Webinar Transcript

Application of High Resolution Climate Models to Benefit Avian Conservation in the Prairie Pothole Region, Northern Great Plains

Speakers:
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Susan Skagen: Thank you all for joining in on the webinar. We're real pleased to be able to report the findings that we've had thus far from a project that we're calling the "Application of High Resolution Climate Models to Benefit Avian Conservation in the Prairie Pothole Region".

Today, John Stamm and I will be making the presentation. We'll be talking a lot about Valerie Steen's work, but she was not able to be here. The Prairie Pothole region of North America has historically been a very important area, especially for breeding waterfowl, that's been recognized for many decades. Perhaps as many as 50 percent of all the breeding waterfowl in North America breed in the Prairie Pothole Region. This region came into existence in its current state about 10 to 12 thousand years ago as the Wisconsin glaciation receded and left small depressions that filled with water.

There are currently, depending on the area that you're talking about, about five to eight million wetlands in this region. The Prairie Potholes not only is important for waterfowl, but we've, in the last decade, found out that it's an extremely important stopover habitat for northbound migrating shorebirds, and especially a lot of the small peeps of the Calidris species.

As you can see, the White-rumped Sandpiper and the Semipalmated Sandpiper travel very long distances, and many of them stop throughout the Prairie Potholes. There are many other wetland-dependent birds in this region, 19 families, 116 species, many of which are in four families.

The Anatidae ducks and geese, the sandpipers, the Laridae, the gulls and the terns, and there's several songbirds that are very dependent on wetland areas as well. We wanted to look at how climate change might be affecting the full suite of birds.

The National Climate Change and Wildlife Science Center has funded a three year project, and there are several PIs on the project. We're looking not only at the birds, but the climate, the ecosystem, processes, and the links between those processes and the bird communities.

Today, we're going to focus the talk on just two pieces of this, the climate component that was done by John Stamm, Parker Norton, and Gary Clow, and one of the avian components that was done by myself and Valerie Steen.

Before we get into those more in-depth, we want to briefly review the work that was done in some of the other components. First J.J. Fontaine and his student Ryan Stutzman, some work done by myself and Lucy Burris on wetlands, work done by Brian Tangen and Robert Gleason on wetlands, and also by Jonathan Friedman.

I'm going to launch first into a couple of these and then I'll turn it over to John. J.J. Fontaine and his student, Ryan Stutzman have looked at a project looking at avian migration in the face of an altered landscape. As you see, there's grass on landscapes.

There's also tilled agriculture. Looking within the context of competition, food availability and predation risk, they wanted to look at what habitat cues the birds were using, how they selected those habitats, with the specific questions of how has habitat alteration affected the stopover decisions?

And what are the implications of them using some of these altered habitats? Lastly, they are currently working on how climate change may affect local phenology.

One of their main findings that I think is very intriguing is that the migrating shorebirds, so not the breeding shorebirds, the migrating shorebirds, especially the small ones, exhibit a strong preference for agricultural fields rather than grasslands.

These are the wetlands embedded in these habitats. Among the agricultural fields, there's a strong preference for soybeans rather than corn, and that has many implications for what the future holds. A second component of the project was the wetland component.

Lucy Burris, Diane Granforth with the Fish and Wildlife Service, and I did a project trying to estimate the amount of sedimentation that's going to be impacting the wetlands in the Prairie Pothole region over the next century.

This was a large-scale project using GIS and a lot of external databases. We used a revised universal soil loss equation and a newer model, the Universal Stream Power Erosion Deposition model.

Basically, our most conservative models predict that within the next century, upwards of a third of the wetlands will probably completely fill with sediment and maybe upwards of a quarter to a half will fill by half with sediments. Many wetlands will exceed a sedimentation rate at which aquatic invertebrate and seedling emergence is suppressed. They found that the landscape covariates were more important in influencing sedimentation rates than the climate variable of annual precipitation here.

It's again a reminder that even though climate change is impending and we're all very concerned, I think we have to note the changes in land use affecting our ecosystems. Now I'm going to turn it over to John to describe the next two pieces and then launch into the climate section.

John Stamm: This is John Stamm. I'm with the South Dakota Water Science Center. I've worked a little bit on this project with Brian Tangen and Robert Gleason up in the Northern Prairies. Brian did the majority of this work. He developed a tool to simulate salinity in some of the wildlife refuges in North Dakota and South Dakota and up into Montana. It was a water and salinity balance model. I had developed it so that managers could maybe use it.

It ended up being a spreadsheet model. It's something that they can grab and use and try to manage some of these impoundments that get a lot of evaporation and can get pretty darn salty. He did a lot of validation and he also did a simulation on a climate scenario. He didn't really make any conclusions on that, just kind of demonstrated that it could be used for that and then demonstrated that it could be used for management goals and objectives along those lines.

There's where you can find that pub, if you're interested. The wetlands they looked at is Bowdoin out in Montana. That's where he did the demonstration of climate scenarios. Then Long Lake in North Dakota and Sand Lake in South Dakota off the Missouri river. Actually, it's on the James.

This next project is one that I was not involved in but I've done some work in paleoclimate and so on. Jonathan Friedman did this work on cottonwood trees. Cottonwood trees typically live right along the edge of the floodplain. They're kind of subject to floodplain erosion. He did a study of cottonwood trees. If you look at this slide out here, he's got some really old ones. Oldest one out there that's recorded, 371 years old. Typically, what you expect is they get a lot younger and then they get lost, they get eroded away over time and die. You get less and less.

You should see this exponential decay but there's these bumps. These bumps tell you that either climate changed or the hydrology changed. We did a study looking at these cottonwoods to see where there may have been times when the floodplain was really growing and climate may have changed a bit. That's right about the end of what's called the Little Ice Age.

This is where we're kind of getting into some of this stuff. This is going to be to some extent a digression to some but Susan asked me to talk a bit about climate trends and projections.

I'd like to acknowledge some of the folks that I've worked with. Parker Norton, a grad student at South Dakota School of Mines, he's doing a lot of the work on this stuff. He also worked directly with us at the USGS office up there in South Dakota. Bill Capehart, his advisor. He's consulted with us on some of this work. Gary Clow, he's in Boulder and with the USGS Earth Surface Dynamics Program. I'll talk about him a little bit more. And also associated with INSTAAR. He does a lot of work up in the Arctic and Antarctica. He goes down there and works with those fun ice cores.

I'm going to start talking about some of the historic trends just to put things in perspective. You want to have something to compare to. I actually look all the way back to 1901 with some of these trends. Looking in the Great Plains and the Prairie Potholes. Then I'm going to look at climate projections going out to 2050 and with some of the models even going out to 2100, to the end of this century. Then I'll focus in on what was going on in the Prairie Pothole region.

The historic trends, I might go through this relatively quickly, skip through it, but a lot of people probably have used this data, this parameter elevation and regression, so an independent slope data called PRISM.

It gives you estimates of monthly total precip, month mean max temperature, and monthly mean minimum temperature. Maximum temperature and precip. It's on a grid. It covers the whole lower 48 states, and it's a 2.5 arc-minute spacing, about four kilometers. Basically, it's weather station records that got interpolated.

It's more complex than that, but let's just say that for now. It's pretty available. You can just get these ASCII ArcGIS grids and bring it in and manipulate the data. It goes all the way back to, actually, 1895, but those grided formats for every month in all those years. I just put this up here to give you an idea of what it might look like.

I've been doing some trend analysis, and this is a PRISM, basically, the mean of annual precipitation from 1901 to 2000, the 20th century there. Just to show some of the resolution, the pixel size, you can get an idea just of the kind of variability that you can see at that scale, that 2.5 arc-minute scale.

Here's the Prairie Pothole region, where I worked with...Susan is going to cut it off a little bit to not have this Montana stuff, but I'm going to show you this full area right here in red, as we look at trends and also look at some of the quantitative model stuff. If I were to average up all the points for every year in that Prairie Pothole region, I'd get an average for each year of what the mean annual temperature was, basically averaging min and max, in this case.

Then, the total annual precipitation for every year. You can see the Dust Bowl dry, a little bit dry, here. It's not as pronounced as if you went south. You can see it's hot. We're going to compare things to the precip trend and to the temperature trend and to just give you an idea, if we just put the linear line through it there, about a degree per century increase over that time, and a 59 millimeters per 100 years per century.

That's the general trend that we can see in the Prairie Pothole region. OK. Climate projections. I'm going to talk about global climate models and then talk about some of our more regional and statistical downscaled models. They call it "Global Climate Models," but that's a little bit, maybe, unfair these days.

It's more than climate. They simulate up oceans, they simulate up the atmosphere, they have biosphere components, so to some extent we call them "Earth Systems Models" now. But, back then, when we started working on this, they basically called them "Global Climate Models." Some people refer to that as GCMs, but, actually, GCMs refer to general circulation of the atmosphere, "General Circulation Model".

These global models are dynamical models. They're simulating up the fluid dynamics of the atmosphere, all those Newtonian kind of equations, thermodynamics, and they're doing it for the atmosphere and the oceans. They're simulating the ocean currents as well. There are these general equations of how the atmosphere behaves, big movements of the atmosphere, the general circulation of the atmosphere, fronts moving, air masses moving.

That's what those are solving. These are sometimes called AOGCMs, and, more recently, Earth Systems Models. I'm not going to go anymore into that. That could be a whole another talk. But I think many of you have an idea of the complexity and how those work. You set up experiments, and there was the Coupled Model Intercomparison Project that said, "Let's all do the same kinds of experiments."

So I'm going to show you the experiments set up by the Coupled Model Intercomparison Project back in 2003 called CMIP3. They said, "Let's first simulate pre-industrial climate some time in late 1800s." Pick a year -- for example, 1870 -- and you simulate it over and over again, try to get the model to settle down, and get a stable climate for 1870.

Then, you start running an experiment where you start simulating up how that model of the planet would behave if I increase greenhouse gases based on the observed increases that I see. We're not trying to simulate the historic climate precisely. We're trying to simulate what a climate system where greenhouse gases are going, and how the Earth would behave.

It's too expensive to precisely simulate up, and maybe even impossible, so it's not called "historic climate," it's called "contemporary climate," because you're simulating what climate is like. That takes from 1870 to 1999 back then. It gives you an idea when these models are being run and set up.

Then, projected climate is then taking...we don't know what the future is. We're going to have emission scenarios. They go several different directions of what the future is. So we don't call it "future," we call it "projected," because we don't really know what the future is, but there are many tracks with each one of these projections that we might go.

In these models, these general circulation models, they go out to 2100. Projected climates are based on emission scenarios. The CMIP3, I'll just give a cruise through of what we mean by these emission scenarios. Emissions are driven by population, technology, land use, other things. What's more important, the environment or the economy?

A is the family of scenarios where the economy is more important. B, the environment. Are you going to respond globally all the same, or are you going to have regional responses? People are behaving differently. If I take A and B, 1 and 2, and look at all those combinations, I get these families of scenarios.

We've been using the A2 scenario. In part, that's because some of the previous dynamical modeling that were starting up was using that as well, and I want to compare things. In the new CMIP5 which came out, the new set of experiments, you're going to hear Representative Concentration Pathways, RCPs, instead of these things.

By the way, A2 is not the worst-case scenario. The worst case, in this, is A1, where everyone's using fossil fuels….the whole globe. That's the worst case in this. Just to put this in perspective, here's CO_2 concentration in parts per million, and then here's the years going back from 1870. This is the community climate model out of NCAR.

Everyone's using these. There's our A2 scenario, how CO2 changes. Other greenhouse gases are changing too. We're doing a lot of simulations out to 2050. You notice that the A family is really the same at that point, so A1 and A2 are pretty much the same things at that point, so you're getting twice the bang for your buck.

This is what the model looks like. This black line is going back to that PRISM data for the Great Plains now, and now I'm showing for the whole Great Plains, of what temperature and precip, the black line for PRISM would be. Here's an example of one General Circulation Model, the CCSM model version three, CCSM3, of how it's following the same kind of pathway of what climate is like through the modern but it seems to be off a bit in...you can see in precipitation.

This is our contemporary climate period. Here is our projected climate period for this model setup. Now I am going to digress again a little bit, and I am doing this because I often get this question when I am talking about. So I'll show this to a manager.

I'll show this to a lot of different people and let's just think I am saying that temperature is looking pretty good. A lot of people look at this and they say, "I think it's kind of lousy. Look, it's down here and you're saying it's down there," and this gets into this realm of simulating what climate is like, versus what climate would be like. That's kind of the difference between a forecast and a climate scientist.

Now, just to kind of maybe put an example, in that we're trying to model the behavior of climate, instead of forecasting exactly the ups and downs in climate. Maybe a way for me and for you all to think about this is…I just kind of give this as an example, and we'll see...I'll put it out there.

If I am out and I walked my dog yesterday and I say, "OK, I want to do a simulation of me walking my dog yesterday." Well, what's the best model that I could develop of me walking my dog? Well, it's me and my dog, and I walk it today, right?

So I can go out and I can walk again and I can walk along that same path but my feet don't fall in the same place. But I am still going along the same path and my dog might have smelled the same tree but it still goes and smells the tree.

My behavior is the same but I am not getting it exactly the same. I am a good dynamical model of me walking the dog and I didn't get it quite the same. But maybe that doesn't matter. Maybe you just want to model the behavior of the system.

So a forecaster might say, "OK. I want you to follow exactly every step you followed last time," but a climate experiment would say, "Well, I don't care that you hit every step but I want to make sure you followed the right path." So that has value in that, even though I am not hitting it, it's showing you how the earth system behaves.

So that's just to give you a little bit of idea of why those curves don't match because it's an experiment of behavior of climate, as opposed to a prediction of exactly what climate was, so we might start being close to the same footsteps and then we start to diverge and then we kind of go out and in the future I can check out if my feet are kind of going right in the right section to time or actually got observations.

All right, so we've got these global models and now we have to make a decision of using regional versus statistical models. I'll just put something about there. This is considerations we had. What kind of time resolution are needed? Do we need...I was hearing a lot of people saying, "I'd like to get hourly and daily stuff." That's more of a regional climate thing.

Variables -- upper atmosphere variables versus just temperature precip or maybe a few other variables. So that's a consideration that we've kind of looked at.

Regional consideration -- this is what Gary was concerned about. He was working in the Arctic and there, climate was way...weather was just doing wacky things that you never had seen before in the observations, and there weren't many weather stations out there.

You might also get into wanting to do climate experiments and not just use this to simulate out to 2050 but do sensitivity experiments as well, and that's what regional climate models are really there for -- to do experiments, be an experimental platform.

OK, so Regional Climate Models, what they need is…they are basically the same thing as the atmosphere part of a GCM, right? But instead of solving for the whole globe, you are resolving those equations in a smaller area.

But you need what is going on on the sides and the base, to provide you boundary conditions in the starting point and you typically get those from Atmosphere-Ocean General Circulation Models. Again, we use the CMIP3 stuff and they're at the emissions, those are based on SRES as opposed to these RCP's.

We didn't really think that we'd want to run our own climate model but there really wasn't much out there at the time but there was this North American Regional Climate Change Assessments Program called NARCCAP, and they did a bunch of runs at the A2 SRES scenario. Some of you maybe familiar with these data. It's 50 km spaced data.

They did historical climate and contemporary climate. Historical means that the boundary conditions actually came from actual observations instead of a GCM experiment, and so I'll just put that out there so those people that are familiar with it, that's kind of what they have there.

Then they did contemporary climate based on a bunch of GCMs and they did two 30-year periods, and again, the A2 emission scenario. And there, you can get the data from those system grid, several variables, 3-hour resolution, and again 50 km spatial resolution.

This is kind of what their world looked like, so think that you're resolving the GCM atmospheric part in this area and it's taking into account that the GCM says winds and moisture and heat are coming in from these edges and maybe coming out of other edges, and it's solving these equations of conservation of mass and so on, computation is relatively expensive.

They used several different Regional Climate Models and then they had several different GCMs that provided data for the boundary conditions. So they got a whole suite. This is bigger than when we were first working with this around 2010. They have added some more models, so this I just got. The list was shorter back then when we were first looking at this.

So here is the Prairie Pothole region. This is our PRISM stuff again that we use as our kind of baseline to compare things to. Here's one of those NARCCAP simulations -- this is a model called WRFG with CCSM out of NCAR, a GCM running given boundary conditions, and you can see they're kind of simulating what climate is like, pretty well here.

There is their projection out in future. One of the issues we had is that there was a big gap in the model output and this 2040 was actually the time period we're really interested in. So we're thinking, "Well, maybe we could fill that gap in and maybe we can attempt to improve precip."

So I started looking at this weather research and forecasting model. Gary Clow was actually using it. This is the Advanced Research WRF is what is used. There's also an operational version of it that's used by NOAA, and we wanted to set this up so we complemented some of the work with this model called RegCM that Steve Hostetler was using.

So we wouldn't duplicate his efforts. We'd have extra data that we could also do comparisons to. The Advanced Research WRF we had, that it just really needs a super computer so we went to University of Colorado. They have a Community Surface Dynamics Modeling System that Gary was already running WRF on to simulate some of the weather systems in the Arctic.

It's got...the USGS actually...it's got this silicon graphics computer with 128 nodes that the USGS actually bought to help with these WRF simulations. So there was an investment there by the USGS. To give you an idea, a 50-year simulation takes about two months. So it takes a while to do just one simulation.

The simulations we did were 36 km horizontal resolutions. We've got 27 vertical levels, 4 soil levels and it solves like every minute but it integrates and puts output about every three hours. So computationally it's making computations at a much finer resolutions than three-hourly.

Parker Norton is doing analysis of if we use historical data to simulate, try to actually simulate the historical, he actually did that from 1981 to 2010. That's called a re-analysis. Again, that's using observation to try to actually get things as accurate.

All right, so we did a WRF simulation re-analysis. We also did this. This is what I am really going to show you here is our contemporary and projected climate. '81, so we did two runs -- '81 to 2010 and then our projection out from 2000 and 2050 and we use CCSM as a boundary in initial conditions for this model.

Why did we use that? Well, OK, so we had to choose one GCM for boundary conditions. So here again is our...this is for the Great Plains and this is our PRISM estimates of temperature and precip.

So we looked at a bunch of different models. We had to choose. You can't use an ensemble, you've actually got to use a specific GCM. So I am going to change this, the color there to black.

All right, now this is the Geo-physical Fluid Dynamics Laboratory. If you simulate...if you ever jump all the points in the Great Plains, and you could see that it's running cool and wet. So we

looked at it and said, "Oh OK. Can we find maybe something that's doing better in the Great Plains?"

Then we looked at the Canadian Center for Climate Modeling, its GCM and it's about the same in terms of its temperatures. It's still too cool, but it did a better job in terms of precip.

Now here is the Community Climate System Model. This is the NCAR model and it's doing much better in terms of temperature and it's doing OK in terms of precip. I am going to get rid of all the others and just kind of show that.

So that's the model that we selected because it seemed to actually produce the best results in the Great Plains, and I've got all the projects that go down in Texas that I am working on as well. So we really do span the Great Plains.

Just to show you the latest CMIP5 version of the CCSM, which is called CCSM4, that's what it looks like for the Great Plains. So it's given about the same story. It looks like it's still a little bit wetter still for the Great Plains but anyways, that's what it looks like.

So we used CCSM3 for this run that we did a few years back. OK, and just I want to throw in there. So here is the heat of 2012. That was a really hot year out there. Just to put it in perspective, once you get out to around 2050, that's going to be a cool year according to these models.

So a little bit of a point of perspective on maybe what the future holds. Not much of a trend in precip. It's pretty darn flat. Even though it's off, but it's still relatively flat.

OK, so that's our CCSM3 boundary in initial conditions. It's just for anyone that's in the climate modeling community. One of the big things that has the uncertainty in these models is what's going on in the sub-grid scale, less than 36 kilometers. And you put in these packages that represent the sub-grid scale.

So we use CAM which is what the GCM actually uses, and there's Kain-Fritsch Cumulus. We played a lot with these Cumulus schemes to try to get Cumulus right. A thunderstorm is much less than 36 km. So you have to estimate cumulus precipitation with these.

This is a non-hydrostatic model which means that you can run it at pretty fine resolutions, and once you get down below 5 km, you don't have to...it actually simulates up.

So here's what the GCM looks like. That's a GCM world of North America. Now this is our domain that we simulated. You can see we got a lot more detail in there so we can simulate stuff up.

I am zooming in now to the Prairie Pothole region and one of the things I always thought was nice, now we can actually see the Black Hills. You got a lot more confidence and stuff. You could actually see things.

So here's the Prairie Pothole region for the U.S. Before showing you Great Plains, I'm kind of flip-flopping back. So this is temperature and precip for each one year for the Prairie Pothole

region. I just changed into black so it'll jump out. There's the GCM. That's the stuff I showed you before, and here is our WRF simulations in the darker line here -- temperature and then precip going out.

I am going to get rid of the GCM so you just see that, so you could see we're doing a pretty good job, in terms of getting the variability.

We kind of miss peaks like that, there in temperature. They're a little bit high in terms of precip. There's our vices about half a degree too cool and then about 76 millimeters a little too warm there. To go back to what we were showing before, there's the NARCCAP stuff. We did kind of improve precip here.

You can see, the temperature for NARCCAP just takes our stuff and keeps on going out. Shows a lot more variability here though. In terms of seasonality, if I were to take for every month the average from 1981 to 2000, the black line is the prism stuff so that's what we're kind of trying to get.

The CCSM in terms of temperature was kind of generally running cool for every month except here. Then we're kind of wavering back and forth with the R simulation. That's just giving you an idea of the monthly vice that we have in the model.

In terms of precip, again, the black line is precip. This GCM is relatively flat, didn't have much in the way of convective precip. We kind of overestimated it. One of the things we did do was get rid of this bimodal discretion. You really don't see this in the Great Plains up to the North but we got rid of that.

This is a map of what the last 10 years of our simulation looks like. Let's compare that to the first 10 years, 2000 and 2001. The last 10 years 2050, 2041 now subtract the first 10 years and look at the temperature change.

The average temperature change, average annual temperature change at each point. You can see the real area where the changes are greatest. Actually, there's a theme around the Prairie Pothole Region. Precip is a little bit more messy. It doesn't show a consistent pattern here.

It actually the precip to that last 10 years, average annual precip for the last 10 years. There's quite a pattern here. It's showing that there's very little change in the potholes but we got some drying areas.

If we were to look at the previous decade, '31 to 2040, it actually would show that things would have been a little bit wetter. We got it on the Geo Data Portal. We've got a publication that's going through their final parts of editing and it will be available.

Some other groups are using it but we'll eventually have it available in the near future. I'm going to hand over to Susan now.

Susan: OK. Thank you, John. Now, I'm going to focus in on the one with the avian components in our regional study that was done. I brought Valerie Steen on the project because she had a lot

of experience in the Prairie Potholes and also we're beginning to be interested in species distribution modeling.

I actually talked her into doing this as a doctoral project. She's currently working under Barry Noon at Colorado State University and myself. The work that I'm going to be talking about today was funded by the NCCWSC and also by the Plains and Prairie Potholes Landscape Conservation Cooperative.

They help provide funding for some of Valerie's graduate work. At the end I will talk about a new project we have as well. For this part of the project, Valerie has been using breeding bird survey data and decided that there was enough data to look at over a hundred species of wetland dependent birds.

There were 31 that had enough data to use and they're varying groups here. Lots of waterfowl, lots of shorebirds. We've got some Grebes, Bitterns. She's building species distribution models with the simple model of the probability of species occurrence being a function of climate variables, wetland variables, and landcover.

She used a quantitative technique called Random Forest which is a classification tree algorithm. It's not a regression. For the species occurrence, to actually build the model she used 40 years of breeding bird survey data for 77 routes.

She partitioned the data into two sets; a model training set to build the model and a model validation set to see how good these models are. Basically, every second year of the survey, since these surveys went through a long period of time, was separated out into another data set.

We've got the training data set and the model validation set.

For climate variables, for building this model, she used PRISM data that John introduced, and decided on 18 different variables of temperature and precipitation. They're basically different seasonalitys. Each of us were seasons, the full past year either average temperature or total precip, five year and 10 year means.

Also, estimates of variability. The standard deviation in the five year and 10 year. The reason we wanted to look at variability is because these systems are so very dynamic in whether or not there's water in some of these wetlands and how deep the water is.

That variability and those fluctuations are actually very important for the ecology of the wetlands. The wetland and landcover variables were derived from available data, National Wetlands Inventory, that was then simplified into a base and coverage.

Also, upland variables. Basically, whether the area was covered with grass, grass and rangeland or whether it was covered with tilled cropland, developed, or trees.

For the wetland variables, there's several different types of wetlands: temporary, seasonal, semi-permanent. If you combine them all you consider those three types the palustrine wetlands. There's also lakes and rivers. We had nine different variables and combinations of those.

She then wanted to test the fit of the models. You have got the training set and the validation set. Across those 31 species, the accuracy was anywhere from 69 to 94 percent. The accuracy is sort of the ratio of the number of correctly predicted presences to the total number of predictions.

Another way of looking at how good the models are is the standard statistic used with Random Forest and that's AUC. Anything over about a .7 is considered a good model. Across these 31 species, they range from .69 to .94. I'd say they're reasonably good models.

She's got the model. She then applied it to historical climate, the period of 1981 to 2000, then applied it to a decade in the future with the projected climate. For the projected climate, we use two different climate models. We used some statistically downscaled data provided to us by the forest service of the Canadian model, the CGCM.

John mentioned that one earlier as being reasonably good for the plains. We started with this before John's data were available. When his became available we used his regional climate model based on the CCSM3. Both of these were with the A2 emissions scenario.

The reason we chose those two models and then either the statistically downscaled or the regional climate model was based on John's prior analysis to see which of these models work the best for the Prairie Potholes. You see, PRISM precipitation here then mean and standard deviation and range, I think.

With the CCSM, which is what he used for his WRF model, the Canadian model, and the GFDL was not as good. Our goal here was not to span the total range of possible scenarios but rather to find the models that are working the best for the region. I'll come back to this point in the future when we talk about our new work.

To orient you on the landscape, with the wetlands and the land coverage, you see a map here, the coverage of the Prairie Potholes Region of North Dakota, South Dakota, and Western Minnesota.

The areas in green are where there's a lot of grassland and you see that that is coincident with the Missouri Coteau over here on the Western part. There's also a lot of wetlands over there on that Western part.

The next maps that I'll show you, you'll maybe keep in mind, the more the Western part, the Coteau regions are where a lot of the grasslands with high wetland content are as well. There are some areas of a lot of tilled agriculture.

Maybe even 60 or more percent of the landscape is, maybe even more than 80 percent of some regions, the landscape is tilled much flatter and in some cases, fewer wetlands.

Let's just look at what the climate content was for the model that she was projecting to. Again, she projected the species distribution models that she built to the historical climate. We have temperature on top, precipitation on the bottom. You see your expected hot to cool gradient going South to North in temperature.

Precipitation is also a gradient. Northwest to Southeast, it gets wetter as you get to the Southeast. Montana area is drier. Western North Dakota is drier. These are actual temperatures and actual precips. This particular slide does not show change. It is the actual.

I want to point out here that in the future, both the Canadian model and John's WRF model, show increasing temperatures. The Canadian model shows about a three degree average increase by the decade 2040 to the 2050 and the WRF model about a four degree.

One thing to point out is you do see that where the orange and red areas are here, this is where the temperature exceeds the range that we saw during the historic period. I just wanted to point that out. Precipitation actually doesn't change very much.

There's maybe only a two or three percent increase in precipitation, in the future, in that particular decade. Another thing I want to point out is that the Canadian model and John's model are not terribly different here.

For the model results, the way we're going to express this is in terms of how much of the range of a given species has been reduced as you go from the historical time period into the future. The range reduction, we define as when the probability of occurrence drops from greater than half to less than half.

You can see here on the scale that we have graded even more than that. Basically, the areas that are brown is where the probability is more than half. More than .5 and the darker the brown the higher the probability of occurrence. Where it's green it is less than half. The lighter the green, the less likely it is to see the bird there.

This an example of historical distribution for one species. Across these 31 species, they really varied in how much of their range would be lost with this climate change. Here we're showing again, the Canadian model and John's model for the 2040 to 2050 decade.

There's a set of species, five of them here, that lose less than 20 percent of their range. The bird that is highlighted in bold here, that's the one that the maps are for. The other ones also had 20 percent or less range reduction. Their maps could vary quite a bit but I'm just going to illustrate it by one in each group.

The numbers in parenthesis are showing the actual range reduction with the two different climate models, the Canadian model and the WRF model. In many situations, for many of these birds, it doesn't change a lot between the two.

But, there are some, the Gadwall here is really wildly different between the two models. The Gadwall is one that the model wasn't good to begin with.

There are more species that had more reduction in their ranges. The Common Yellowthroat is illustrated in this group of slides. You see the amount of area where you expect to see the bird has declined through time. It seems to be declining throughout. It's not just shifting north but rather just declining throughout.

There's more birds, another set of eight birds here that experienced 40 to 60 percent expected range deduction, which is pretty dramatic. We get to some that exceed to 80 percent and some that are even going to experience up to 100 percent of their range reduction.

If you look at the most sensitive birds here, you'll see some birds here like the Sedge Wren, the Sora, in particular that really do like shallow water habitats.

The Black Tern likes a lot of fluctuating water levels. If it gets too dry and the waters don't fluctuate...What is responsible for these range reductions? The way Random Forest gives you the findings is it tells you, it ranks the variables of importance.

Remember there are 18 climate variables and nine wetland and upland variables. For each species, you can look at what are the top 10 variables that affect, and this would be in the building phase of the model, that affect these bird's distribution.

Instead of having five categories of how much range reduction...Valerie broke it into three: those that experience the most range reduction, those are that are moderate and those that experience the least range reduction.

The ones that experience the most range reduction are actually the ones that are more sensitive to temperature and precip. In almost all cases it was a negative relationship with temperature. The hotter it got, the more constricted the distribution.

Precipitation went both ways, depending on the ecology of the species. It was still the wetland coverages that really defined a lot of the distribution in these birds to begin with.

Remember, this wetland coverage, it's the wetland basins. It's not whether or not there's water in the wetlands but just the wetland basins that are available for water based on National Wetlands Inventory Data.

We have a lot of interrupting of these figures to do. We do see that in the group that is experiencing the least range reduction, we'll have birds like the Ruddy duck or the Redhead diving ducks that like the big water.

They were not really very responsive to changes in temperature and precipitation because the big water might be a little bit smaller but it's still pretty big. They're in a lot of the semi-permanent wetlands.

I also want to mention here just to clarify, we are seeing temperature and precipitation more as a surrogate for how much water there is probably in these wetlands. Temperature could also be affecting the birds physiologically if it gets too hot. There's still a lot to be done in this area.

In fact, we have a new project that is being funded by the North Central Climate Science Center, where we're going to be using some of the same species distribution models, actually building on them and then asking the question about the use of surrogate species to manage wetland dependent birds in the Prairie Pothole Region.

We have assembled a team, again myself, Barry Noon and Valerie, a postdoc Helen Sofaer. John is helping us with the project with the climate data. We're also working with Dr. Ben Rashford with the University of Wyoming, who is an economist. He has a postdoc working with him, Gordon Reese.

We have many very important partners here. The Plains and Prairie Potholes Landscape Conservation Cooperative, the PPJV and the Fish and Wildlife service. All of the participating states, tribes, and NGOs that the LCC is currently working with.

The question for this work really did come out of the people that know a lot about the Prairie Potholes: the researchers at the HAPET office in Bismarck and the managers have been wondering about.

Historically, a lot of the wetland management has been done based on waterfowl distributions. Primarily, these five species of waterfowl.

They'll identify areas on the landscape where you can expect very high densities of ducks and try to protect as much of that habitat as they can through wetland easements and other mechanisms. But, they're wondering, do waterfowl effectively serve as surrogates for other species?

Now, we have a 116 species of wetland dependent birds that we need to think about. The idea of surrogate species as a tool in management is something that's really very much in the forefront at the Fish and Wildlife Service these days.

They recognize it's impossible to manage for every species so you need to select some to really focus on. This approach just assumes similar habitat needs and it should send similar responses to ecological change if in fact we're going to be looking at how climate change is affecting these.

The objective of this new study is to test the use of surrogate species, both under contemporary and projected climate and land use scenarios and then to help the managers assess whether the conservation areas that they currently have purchased for waterfowl can also provide habitat into the future for other species.

We're going to do some major improvements on these basic species distribution models that Valerie has done. She will be working on this project and continuing her doctorate.

The North Central Climate Science Center has some very good computer resources and we will be using what is called the Software for Assisted Habitat Modeling to expand on the number of statistical approaches to species distribution modeling we can use.

In addition to Random Forest, we can use logistic regression; Maxent, logistic regression trees and other ones. There has been quite a bit of attention in this world of species distribution modeling, how the different statistical techniques actually end up portraying these distributions.

We want to use additional climate projections as well. We have two currently that we selected based on what is probably the best climate data you can get for that area, and we are working in consultation with the climate working group of the Climate Science Center to select some additional climate projections.

From that, we will probably compare how all of these different climate projections and statistical packages yield results to see how much variability there is to get a sense of how much uncertainty there is.

We'll probably also be working with ensemble models. Just very briefly, I want to talk about some other additions to this effort. Dr. Helen Sofaer is currently working on layer to project the condition of the wetlands, that's how much water is in the wetlands, using May pond counts.

This is an effort that's also being worked on by Neal Niemuth at the HAPET office in Bismarck. He's using a different approach that is also bringing in some of the tile and draining information that he has, and we're anxious to see how that transpires.

Then Dr. Rashford is going to be developing models of land use change based on remotely sensed data, these biophysical variables, but also economic theory of how crops might change, and especially as ethanol has been sort of a big influence up there.

He will be providing us with a layer of future projected land use as well. Finally, we're going to develop tools where we can take all these species distribution models, these much improved species distribution models, compare them with the surrogate species that the managers select, and actually build a tool and integrate that software into the Climate Science Center infrastructure.

With that, I'd like to acknowledge the wonderful support that we've gotten from the NCCWSC, the PPPLCC, now the Climate Science Center, and also the HAPET office, the Forest Service for providing a lot of data. Lucy Burris did a lot of the GIS support and data management for the project.

That is it. Does anyone have any questions?

Ashley: Excellent. Thank you Susan and John.

Norman: This is Norman, can you hear me?

Susan: Yes, we can.

Norman: Excellent. I really enjoyed this presentation. John, you did a great job of laying the groundwork, which I think gets glossed over a lot of times on this stuff, about all the complexities of the GCMs and the downscaling and all of those kinds of things. That was really great.

Susan: He's really good at that.

John: Thank you.

Norman: It's a lot of stuff. It's like trying take a small sip from a fire hose is the analogy that comes to mind.

John: Yep.

Norman: Susan, I wanted to see if I could clarify something from you. I may have just missed this, but I'm really unclear on how the variables that come out of the GCMs like precipitation and temperature actually get integrated, if you will, through your modeling into the range reduction. Is it a mechanistic model that has things like...How often are these potholes three inches deep or greater or how often are the temperatures above a certain amount. I lost where that linkage is and how mechanical it is and so on.

Susan: Yeah, at this point and time it's basically correlative. We don't have a mechanistic model here and that's what we're hoping to get some more insights with Helen Sofaer's work and with Neil Niemuth's work. There are other people in the potholes working on a lot of these questions as well. Right now, we pull out the variables from the climate data, express it in terms of monthly data and then repackage it to form the variable.

Like, "OK, in the last year how much total water was in this grid cell? What was the average temperature in the last year or in different seasons? Or five year or 10 year periods?" That goes into building the model. These original...the training sets is what was used to build the model. It's Random Forest, which is different from an aggression analysis but I think the analogy is the same. It's more of a correlation than a mechanistic model.

Norman: OK. Is that...

Susan: She would build the model and then project the model using new climate data. You have your definition of your model and then you go and apply your future average temperature for each different time period, relative to what the model says.

Norman: OK.

Susan: I am sure that was clear as mud. You've got Valerie's email and she has got a paper that's been in review for some time on this. It's still undergoing some revisions now but I am sure that she would be happy to talk to you about more details too.

Norman: OK. That helps, thank you very much.

Jeff Morisette: Hi. So not so much a question but a complement. I thought it was a really good job. I agree with this previous comment that John does a great job going into those details that are often glossed over and appreciating NCCWSC's funding of a project that will then lead to a useful climate data that we'll use in the North Central.

And then to put in that shameless plug, that that software that Susan mentioned, there's training every six months at the USGS Fort Collins Science Center. I think the next training is coming up March 25, 26 and 27 and it's posted through the DOI Learn website.

So with that question, and maybe others are interested in learning more about that, that is something that would be ongoing and offered on this information on that software and those tools.

Ashley: We had a question come in from Sonia Hall and she says, "Are you considering looking at the potential impacts of climate change on the wetland variables? A student at the University

of Washington, Megan Hobbiski, working with Josh Lawler and Alan Hamlet are looking at this question in Washington State. Using a combination of the high-resolution images to map wetlands and landsat to describe dynamic and climate change projections."

Susan: We don't have an effort that is quite that energetic. It sounds like a wonderful effort. Helen Sofaer is currently using the May pond count data, which is a Fish and Wildlife Service survey that's been going on since 1957 that looks at number of ponds in the area, which is an index of how much water there is, and she will be using that.

It will be kind of an index but at this point in time, I would love to have a model that really can help relate climate directly to what the water levels in the region are, in the wetlands in the region.

One of the real difficult things in that model, and why I think it hasn't been approached quite in that way is that in these agriculture areas, there's a lot of tiling and draining that goes on that basically overrides any effect of the climate in a localized area. I don't think there are very accurate coverages of where this activity has gone on.

I think it covers a good percentage, probably less than 20, maybe even less than 10, of the potholes based on a paper I just saw. But anyway, I would love to see an effort like that and I think there's a lot of other folks working on these mechanistic models that hopefully will come up with some of these projections.

John: Now, I am just going to chime in here just a little bit, the dynamical models have got up a fair bit of hydrologic variables. They got a cycle going, and so on through there. Susan and I had discussion with Joe Barsugli at NOAA just the other day, just...two days, yesterday?

Susan: Yesterday.

John: ...it's going fine, but anyways, we were talking about the importance of actually using these hydrologic variables out of the models. One thing to remind folks is that we do these runs that are based on these climate experience experiments with GCMs but there's also these re-analyses that kind of do a pretty good job of simulating historic climate changes.

So those help some. They can provide some things along the lines of soil moisture and so on, that we are kind of discussing maybe bringing into some of these tree...what's it called -- tree model?

Susan: Random Forest.

John: Random Forest.

[laughter]

Susan: Yeah.

John: I'm an amateur tonight. All right, Random Forest -- those kinds of models, trying to bring those kinds of hydrologic variables into the models.

Susan: And I'd like to just add, Jennifer Rover up at EROS Data Center in South Dakota is actually doing a project at a smaller scale, maybe two counties within North Dakota, Stutsman and Kidder counties, in conjunction with some other researchers, that's looking at that type of an effort. It'll be really nice to see how she develops some methodology that perhaps we can expand out over a larger region.

Ashley: Excellent. Thank you.

All right, Holly or Shawn, are you still on the line?

Shawn: We are, and no comments from us, other than just to thank Susan and John for a wonderful presentation.

Susan: Well, you're welcome. Thank you for giving us the opportunity to give it.

John: Yes, thank you very much.

Shawn: Great.

Ashley: Great. Thank you everybody, and I just wanted to say thank you to the participants as well.

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